WE CLAIM:

3

1.   A process for creating a broadly tunable Distributed Bragg Reflector (DBR) structure with a low spontaneous recombination rate at operating temperatures

6   comprising the steps of:

creating a first cladding layer of a first conductivity type;

creating an optical waveguide disposed on top of said first cladding layer

9   comprising the steps of creating one or more hole confinement regions and

creating one or more electron confinement regions wherein energy barriers of

greater than the thermal energy, kT, separate adjacent confinement regions;

12   creating a second cladding layer of a second conductivity type disposed on

top of said optical waveguide.

2.   The process of claim 1 further comprising the step of creating a grating layer.

15   3.   The process of claim 1 wherein:

a conduction band energy barrier greater than the thermal energy, kT, is

created by establishing an effective conduction band offset between adjacent

18   confinement regions;

a valence band energy barrier greater than the thermal energy, kT, is

created by establishing an effective valence band offset between adjacent

21   confinement regions;

the band gap of said first cladding layer and the band gap of said second

cladding layer are greater than the effective band gaps of said hole confinement

24   regions;

the band gap of said first cladding layer and the band gap of said second

cladding layer are greater than the effective band gaps of said electron

27   confinement regions;

a first cladding layer conduction band energy barrier greater than the

thermal energy, kT , is created by establishing an effective conduction band offset

30   between the conduction band of said first cladding layer and the conduction band

of the adjacent confinement layer;

a second cladding layer conduction band energy barrier greater than the

33   thermal energy, kT , is created by establishing an effective conduction band offset

between the conduction band of said second cladding layer and the conduction

band of the adjacent confinement layer;

36   a first cladding layer valence band energy barrier greater than the thermal

energy, kT , is created by establishing an effective valence band offset between

the valence band of said first cladding layer and the valence band of the adjacent

39   confinement layer; and

a second cladding layer valence band energy barrier greater than the

thermal energy, kT , is created by establishing an effective valence band offset

42   between the valence band of said second cladding layer and the valence band of

the adjacent confinement layer.

Broadly Tunable Distributed Brag Reflector Structure Processing   NOVA-P022

4.   The process of claim 1 wherein said first cladding layer comprises an n-type

45   cladding layer and said second cladding layer comprises a p-type cladding layer.

5.   The process of claim 1 wherein said first cladding layer comprises a p-type

cladding layer and said second cladding layer comprises an n-type cladding layer.

48   6.   The process of claim 3 wherein a valence band energy barrier greater than twice

the thermal energy, 2kT, is created by establishing an effective valence band offset

between adjacent confinement regions.

51   7.   The process of claim 3 wherein a conduction band energy barrier greater than

twice the thermal energy, 2kT, is created by establishing an effective conduction band

offset between adjacent confinement regions.

54   8.   The process of claim 3 wherein a cladding conduction band energy barrier equal

to greater than twice the thermal energy, 2kT, is created by establishing an effective

conduction band offset between the conduction band of said first cladding layer and the

57   conduction band of the adjacent confinement layer.

9.   The process of claim 3 wherein a cladding conduction band energy barrier equal

to greater than twice the thermal energy, 2kT, is created by establishing an effective

60   conduction band offset between the conduction band of said second cladding layer and

the conduction band of an adjacent confinement layer.

10.   The process of claim 3 wherein a cladding valence band energy barrier equal to

63   greater than twice the thermal energy, 2kT, is created by establishing an effective valence

band offset between the valence band of said first cladding layer and the valence band of

the adjacent confinement layer.

Broadly Tunable Distributed Brag Reflector Structure Processing   NOVA-P022

66   11.   The process of claim 3 wherein a cladding valence band energy barrier equal to

greater than twice the thermal energy, 2kT, is created by establishing an effective valence

band offset between the valence band of said second cladding layer and the valence band

69   of the adjacent confinement layer.

12.   The process of claim 3 wherein the step of creating said broadly tunable DBR

comprises creating one or more graded layers.

72   13.   The process of claim 12 wherein said first cladding layer comprises one or more

graded layers.

14.   The process of claim 12 wherein said second cladding layer comprises one or

75   more graded layers.

15.   The process of claim 12 wherein said optical waveguide comprises one or more

graded layers.

78   16.   The process of claim 12 wherein said graded layer varies in composition across

the thickness of said optical waveguide.

17.   The process of claim 12 wherein said graded layer varies in energy band structure

81   across the thickness of said DBR.

18.   The process of claim 12 wherein said graded layer varies in composition across

the breadth of said DBR.

84   19.   The process of claim 12 wherein said graded layer varies in energy band structure

across the breadth of said DBR.

20.   The process of claim 3 wherein the thickness of said optical waveguide is selected

87   to support a single optical mode.

Broadly Tunable Distributed Brag Reflector Structure Processing   NOVA-P022

21.   The process of claim 3 wherein said optical waveguide comprises one electron

confinement region and one hole confinement region wherein said electron confinement

90   layer comprises a layer of material of uniform composition and said hole confinement

layer comprises a layer of material of uniform composition.

22.   The process of claim 3 wherein said optical waveguide comprises one electron

93   confinement region and one hole confinement region wherein said electron confinement

layer comprises a layer of material of uniform energy band structure and said hole

confinement layer comprises a layer of material of uniform energy band structure.

96   23.   The process of claim 3 wherein adjacent confinement regions comprise layers of

lattice matched materials.

24.   The process of claim 23 wherein said electron confinement regions comprise

99   InGaAsP material lattice matched to InP and said hole confinement regions comprise

InGaAlAs material lattice matched to InP.

25.   The process of claim 23 wherein said electron confinement regions comprise

102   InGaAsSb material lattice matched to InP and said hole confinement regions comprise

InGaAlAsSb material lattice matched to InP.

26.   The process of claim 3 wherein the thickness of said electron confinement regions

105   is greater than the thickness of said hole confinement regions.

27.   The process of claim 3 wherein the effective conduction band offset between

adjacent confinement regions is greater than the effective valence band offset between

108   adjacent confinement regions.

28.   The process of claim 3 further comprising the step of creating one or more graded

layers disposed between said optical waveguide and said first cladding layer.

Broadly Tunable Distributed Brag Reflector Structure Processing   NOVA-P022

111   29.   The process of claim 3 further comprising the step of creating one or more graded

layers disposed between said optical waveguide and said second cladding layer.

30.   The process of claim 3 further comprising the step of creating one or more graded

114   layers disposed between adjacent confinement regions.

31.   The process of claim 1 further comprising the step of creating one or more

additional cladding layers.

117   32.   The process of claim 1 wherein said energy barriers are created by band gap

tilting wherein:

said optical waveguide comprises a layer of graded material wherein the

120   energy level of the lowest conduction band of said waveguide increases across the

thickness of said waveguide, the energy level of the highest valence band of said

waveguide increases across the thickness of said waveguide and the energy band

123   gap of said waveguide varies across the thickness of said waveguide;

the changes in said energy levels creates an electron confinement region in

said optical waveguide comprising a region wherein said energy level of the

126   lowest conduction band and the adjacent cladding layer forms a local minimum in

the conduction band;

the changes in said energy levels creates a hole confinement region in said

129   optical waveguide comprising a region wherein said energy level of the highest

valence band and the adjacent cladding layer forms a local maximum in the

valence band;

Broadly Tunable Distributed Brag Reflector Structure Processing   NOVA-P022

132   the average band gap of said optical waveguide is greater than or equal to the carrier concentration in said optical waveguide divided by twice the thickness of said optical waveguide.

135   33.   The process of claim 32 wherein:

     said optical waveguide comprises one or more layers of material wherein the energy band structure varies across the breadth of said waveguide.

138   34.   The process of claim 32 wherein said conduction band and said valence band of said graded layer comprise sloped, stepped or curved profiles across the thickness of said optical waveguide.

141   35.   The process of claim 32 wherein the materials composition of said graded layer comprise sloped, stepped or curved profiles across the thickness of said optical waveguide.

144   36.   The process of claim 32 wherein said conduction band and said valence band of said graded layer comprise sloped, stepped or curved profiles across the breadth of said optical waveguide.

147   37.   The process of claim 32 wherein the materials composition of said graded layer comprise sloped, stepped or curved profiles across the breadth of said optical waveguide.

1

Broadly Tunable Distributed Brag Reflector Structure Processing   NOVA-P022